(19) Canadian Intellectual Property Office
An Agency of Industry Canada

Office de la Propri,t, Intellectuelle du Canada
Un organisme d'Industrie Canada

(11) CA 2 291 375 (13) A1
(40) 25.05.2001
(43) 25.05.2001

(12)

(21) 2 291 375
(51) Int. Cl.7: A61M 16/01
(22) 25.11.1999

(71)
BUCKINGHAM, WILLIAM,
4940 21 Avenue N.W., CALGARY, A1 (CA).
BART, BEVIN,
UNKNOWN, UNKNOWN, XX (ZZ).

(72)
BUCKINGHAM, WILLIAM (ZZ).
BART, BEVIN (ZZ).

(74)
SIM & MCBURNEY

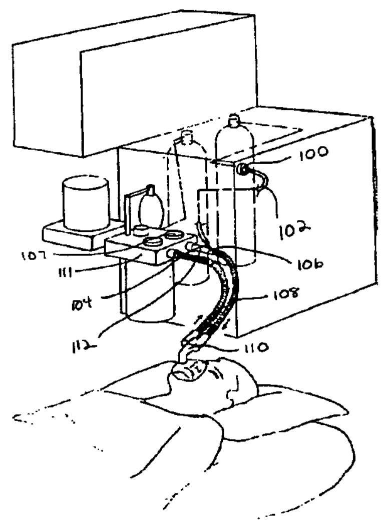
(54) APPAREIL ANESTHESIQUE RESPIRATOIRE
(54) ANESTHETIC BREATHING CIRCUIT

OPIC
OFFICE DE LA PROPRIÉTÉ INTELLECTUELLE DU CANADA
CIPO
CANADIAN INTELLECTUAL PROPERTY OFFICE
(12) (19) (CA) Demande-Application
(21) (A1) 2,291,375
(22) 1999/11/25
(43) 2001/05/25

(72) BART, BEVIN, UNKNOWN
(72) BUCKINGHAM, WILLIAM, UNKNOWN
(71) BART, BEVIN, UNKNOWN
(71) BUCKINGHAM, WILLIAM, UNKNOWN

(51) Int.Cl.^{7} A61M 16/01

(54) APPAREIL ANESTHESIQUE RESPIRATOIRE
(54) ANESTHETIC BREATHING CIRCUIT



ANESTHETIC BREATHING CIRCUIT

Field of the Invention

The present invention relates to a novel anesthetic delivery system which is particularly useful for the delivery of sevoflurane but which may also be applied to other inhalant anesthetics. Most particularly, it relates to a method of delivering fresh anesthetic gas to the inspiratory limb of a breathing apparatus.

Background of the Invention

Anesthetics which can be inhaled are commonly used in a variety of operating room scenarios. They are particularly useful in situations where the patient has a fear of needles. Ether was one of the first inhalant anesthetics to be used widely. Today, halogenated isopropyl derivatives of ether have demonstrated promise for use in the medical field due to their anesthesia inducing properties. Of these, the most successful to date have been the fluorinated isopropyl ethers such as sevoflurane (fluoromethyl--1,1,1,3,3,3-hexafluro-2-propyl ether)which is marketed under the tradename, ULTANE, by Abbott Laboratories. Sevoflurane has demonstrated rapid induction and recovery from anesthesia when administered by inhalation, making it attractive for use as an anesthetic. Further, sevoflurane is a volatile liquid, nonflammable in air at ambient temperatures and has a lower flammability limit in oxygen of about 11.8 volume percent, making it safe

to use as well. United States Patent 3,683,092 to Regan et al. discloses use of sevoflurane as an anesthetic and Canadian Patent Application No. 2,155,002 discloses deuterated sevoflurane as an inhalant anesthetic with fewer side effects.

An object of one aspect of the present invention is to provide a means for delivering sevoflurane, or other inhalant anesthetics, to a patient in a manner such that the patient is anesthetized rapidly, i.e within a few breaths.

Another object of an aspect of the invention is to reduce costs by more efficient priming of the breathing apparatus system.

Sevoflurane and other inhalant anesthetics are usually dispensed in liquid form to an apparatus, such as an anesthetic vaporizer, which mixes the anesthetic with other gases. The gas mixture is then supplied in gaseous form to the patient for inhalation through an inspiratory tube. This inspiratory tube typically forms part of the inspiratory limb of a breathing circuit which also comprises an expiratory limb. The tubing associated with the inspiratory and expiratory limbs are connected via a Y-connector. Typical anesthetic vaporizer systems are described in Canadian Patent Application No. 2,186,891 and United States Patent No. 5072726.

Ventilators and anesthetic systems are typically equipped with a number of safety valves. United States Patent No. 5694924 describes an anesthetic system which has an inspiratory line, an expiratory

line and a connecting line which together form a closed system. Check valves are arranged in the connecting line to control the direction of gas flow. The system further comprises two gas reservoirs which are functionally interconnected so an increase in volume of one results in a corresponding reduction in the volume of the other. This is just one example of the various different kinds of anesthetic systems which exist. However, most of the existing systems incorporate a step of mixing the fresh gas with other gases before the mixed gas enters the inspiratory line.

Summary of the Invention

The present invention provides for a method and apparatus which enhance the efficiency of inhalant anesthetic delivery.

According to one aspect of the invention, there is provided an anesthesia system for providing anesthesia to a patient which comprises:

i) an essentially circular breathing circuit adapted to be connected to a patient, said system having an inspiratory limb for introducing gases to a patient, an expiratory limb for receiving exhaled gases;

ii) check valves to allow flow within said circuit only from the direction of said expiratory limb to said inspiratory limb,

iii) an absorber for removing carbon dioxide from the gases circulating in the circuit;

iv) means to supply a gas to said circuit; and

v) means to introduce fresh anesthetic from a reservoir into said circuit;

wherein said means to introduce fresh anesthetic is connected directly to said inspiratory limb.

In accordance with another aspect of the invention, there is provided a method of delivering an anesthetic to a patient which comprises priming a breathing circuit with anesthetic by direct input of anesthetic into an inhalation limb, applying said breathing circuit to a patient and allowing the patient to inhale the anesthetic.

Brief Description of the Drawings

Certain embodiments of the invention are described below, reference being made to the drawings, wherein:

Figure 1 is a prior art illustration of a circle breathing system;

Figure 2 is a prior art illustration of a typical anesthesia delivery system;

Figure 3 is an enlarged view of the gas flows in a typical anesthesia system;

Figure 4 is a schematic illustration of the anesthesia delivery system of the present invention;

Figure 5 is an illustration comparing fresh gas flow in known systems and the system of the present invention; and

Figure 6 is an exploded view of the connecting components of the present invention.

Detailed Description

A system is provided for delivering fresh gas to a patient connected to a circle system anesthetic delivery system. As shown in Figure 1, the basic components of a circle breathing system 10 are an inspiratory 12 and expiratory 14 limb, each with a unidirectional valve 16, 18, respectively, and a reservoir bag or counterlung 20 moving reciprocally with the patient's lungs (Anesthesia Equipment: Principles and Applications, Mosby 1993 p100-101). The system may be divided into quadrants, A, B, C, and D. Two corrugated breathing tubes 22, 24 typically connect the patient 26 and the counterlung 20, which may be a bag or ventilator bellows. The counterlung may be connected to the system via a T-piece 21 and the patient is usually connected to the system via a Y-piece 25. One way valves are located in the inspiratory 12 and expiratory 14 limbs. The patient 26 and the counterlung 20 separate the inspiratory 12 and expiratory 14 limbs of the system and the valves separate the patient from the bag side of the system. The position of the valves 16, 18 within the limbs are not necessarily fixed. Additional components usually found in a circle system include a carbon dioxide absorber 28, a fresh-gas inflow site 30 and an adjustable pressure limiting valve 32 for venting excess gas. The usual site for the carbon dioxide absorber is in the inspiratory limb. The fresh gas inflow is usually located in the inspiratory limb downstream from the carbon dioxide absorber and the pop-off valve is

usually downstream from the expiratory valve near the bag.

The present invention applies the principles of a circle system to the delivery of an anesthetic such as sevoflurane. A typical anesthetic delivery system, such as the Datex-Ohmeda ADU Anesthesia System, is illustrated in Figure 2. The system 40 comprises a fresh gas supply connection 42 through which fresh gas flows into the system. There is also a manual ventilation bag 44, a ventilation bellows 46 and a ventilation hose 48. The ventilation hose 48 is connected to a block 50 which includes valves 52 for inspiration and expiration. The gases from the fresh gas supply and from the ventilation hose are mixed and enter the inspiratory tubing 54 to the patient. The inspiratory tubing is connected via a Y-piece 56 to the expiratory tubing 58. Carbon dioxide in the expired gases may be removed in the absorber canister 60 and the gases recycled.

An enlarged view of the gas flow in a typical anesthetic system under conditions of spontaneous ventilation is shown in Figure 3. Fresh gas from the anesthesia system enters the common gas inlet 62, then flows through the inhalation chamber 64, the inspiratory valve 66 and out the inhalation port 68 to the patient. Upon exhalation, gas returns through the expiratory valve 70 and into the exhalation chamber 72. Gas flows from the exhalation chamber to the breathing bag 73. Upon compression of the breathing bag, excess gas is vented through the excess gas outlet 74 and the remaining volume of gas

indicated by arrows 75 enters the canister 76 and travels downward for carbon dioxide absorption. Gas returning from the bottom of the canisters, indicated by arrows 78, enters the inhalation chamber 64 and joins incoming fresh gas.

In this type of circuit one must prime the circuit, i.e. the concentration of anesthetic gas must be made uniform throughout the entire circuit. This includes the plastic tubings to the patient, the breathing bag, the carbon dioxide absorber canister and the associated connectors. This requires a high volume of gas and it takes considerable time and effort to prime the circuit so that the anesthetic gas is uniform throughout as is required for delivery of high concentration of gases to the patient for rapid loss of consciousness.

Thus, while these types of systems have proved useful, a major drawback is the large volumes of gases required to prime the system in the first place. There are also dilution effects on the anesthetic gases since the fresh gas inlet comes in the rear of the common gas outlet.

The present invention has addressed these problems by modifying the inhalation limb such that anesthetic gas is delivered directly to this limb without passing through the canister. This has the surprising result that lower gas flow rates can be employed and the system can be more efficiently primed to deliver the anesthetic rapidly to the patient.

Referring now to Figure 4, this figure illustrates a preferred embodiment for delivering anesthetic gas directly from the common gas outlet to the inspiratory limb of the breathing system. Anesthetic gas from the anesthesia system enters the common gas outlet 100 and then flows into a fresh gas tubing 102. The fresh gas tubing 102 is connected to the minor arm 104 of a Washington T-piece 106. It will be clearly apparent to one skilled in the art that other types of connectors, such as, for example, an Ayers T-connector could also be used to achieve the same result. Thus, the fresh gas enters the circuit downstream of the inspiratory valve 107. Means are provided to control the amount of anesthetic delivered to the patient. The anesthetic gas flows along the inspiratory tubing 108 to the Y-junction 110 where it is inhaled by the patient. Thus, fresh gas can be delivered more efficiently without being diluted in an inhalation chamber. This allows the system to be primed more efficiently and promotes the rapid delivery of anesthetic to the patient such that it only requires a few breaths for the anesthetic to take effect.

Typically, concentrations of gases found in a circuit are dependent upon two factors. The first factor is the concentration of the anesthetic gas mixture delivered into the circuit. This is usually accomplished by setting a flow of oxygen and nitrous oxide/air via the flow controllers. The gases are mixed with the anesthetic agent in the vaporizer and this mixture is delivered to the circuit. The

concentration of the anesthetic agent is adjusted using a dial on the vaporizer. The second factor is the anesthetic uptake by the patient. Within a few minutes a state of equilibrium is usually established in the gas concentration between the patient uptake and the concentration of anesthetic gas mixture delivered.

In the present invention, the placement of the anesthetic gas inlet into the inspiratory limb on the patient side of the inspiratory valve has the surprising result that the inspiratory limb of a ventilation circuit can be filled with a high concentration of anesthetic in a very short, almost instantaneous, time period. This positioning of the inlet also allows the inspiratory limb to act as a reservoir that continues to supply the patient with high concentration gases upon subsequent inspirations by the patient. This delivery of high concentration gases in the initial phase promotes surprisingly rapid induction using sevoflurane. Similar results would be expected using other inhalant anesthetics.

A further surprising advantage of the present invention is that the positioning of the anesthetic inlet creates a slight back pressure which keeps the inspiratory valve closed. This further impedes dilution of the anesthetic gas by the gases returning via the carbon dioxide absorber canister. Because the valve is kept closed with back pressure, flow returned via the carbon dioxide absorber is limited. In this way, the patient's initial and important first few breaths are loaded with high concentration

anesthetic gas allowing for rapid loss of consciousness. This is important for patient-controlled induction or autoinduction as well as for rapid loss of consciousness.

Thus, the present invention has significant advantages in terms of pharmacoeconomics, patient satisfaction and ease of use for the anesthesiologist.

Figures 5A and 5B are schematics illustrating how the fresh gas is delivered to the patient. Figure 5A is representative of the known methods of delivering inhalant anesthetics. Fresh gas 116 and other gases 118 enter an inhalation chamber/CO2 absorber 120 and then proceed into the inspiratory limb 122 of the Y-shaped breathing apparatus 124.

Figure 5B, on the other hand, illustrates how the fresh gas 116 can bypass the inhalation chamber 120 and enter directly into the inspiratory limb 122 through a T-piece inlet 126. A valve 130 controls the flow rate. This has the surprising advantage of more efficient priming of the system, more rapid onset of unconsciousness and reduction in costs due to the lower amounts of anesthetic required.

Figure 6 illustrates how this effect can be achieved by connecting tubing 134 from the fresh gas outlet to the side projection 136 of a Washington T-piece 138. Although a Washington T-piece has been illustrated for exemplary reasons, it would be clear to one skilled in the art that various other types of connectors could be used to achieve the same result. The larger bore inlet 140 of the Washington T-piece

is connected to an adapter 142 which connects to the inhalation port. The stem 144 of the T-piece is adapted to fit over a complementary protrusion 146 on the end 148 of the corrugated tubing 150 of the inspiratory limb.

Thus, the present invention provides for efficient inhalant anesthetic delivery by delivering the fresh gas directly into the inspiratory limb. This has surprising benefits for the patient in that an effective amount of the anesthetic is delivered more rapidly, thereby reducing stress. There are also surprising benefits to the health care provider in terms of cost savings due to the more efficient priming of the system.

Although preferred embodiments of the invention have been described herein in detail, it will be understood by those skilled in the art that variations may be made thereto without departing from the spirit of the invention.

PRIOR ART

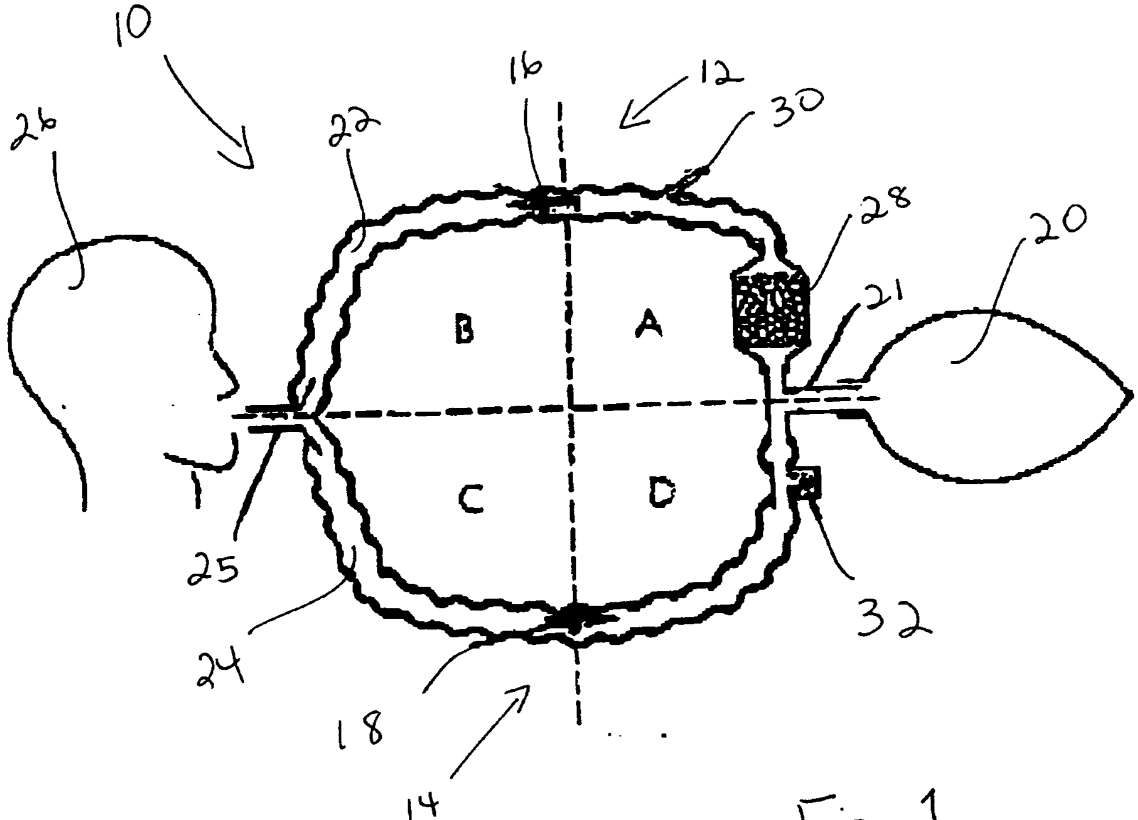


Fig. 1

CA 02291375 1999-11-25

PRIOR ART

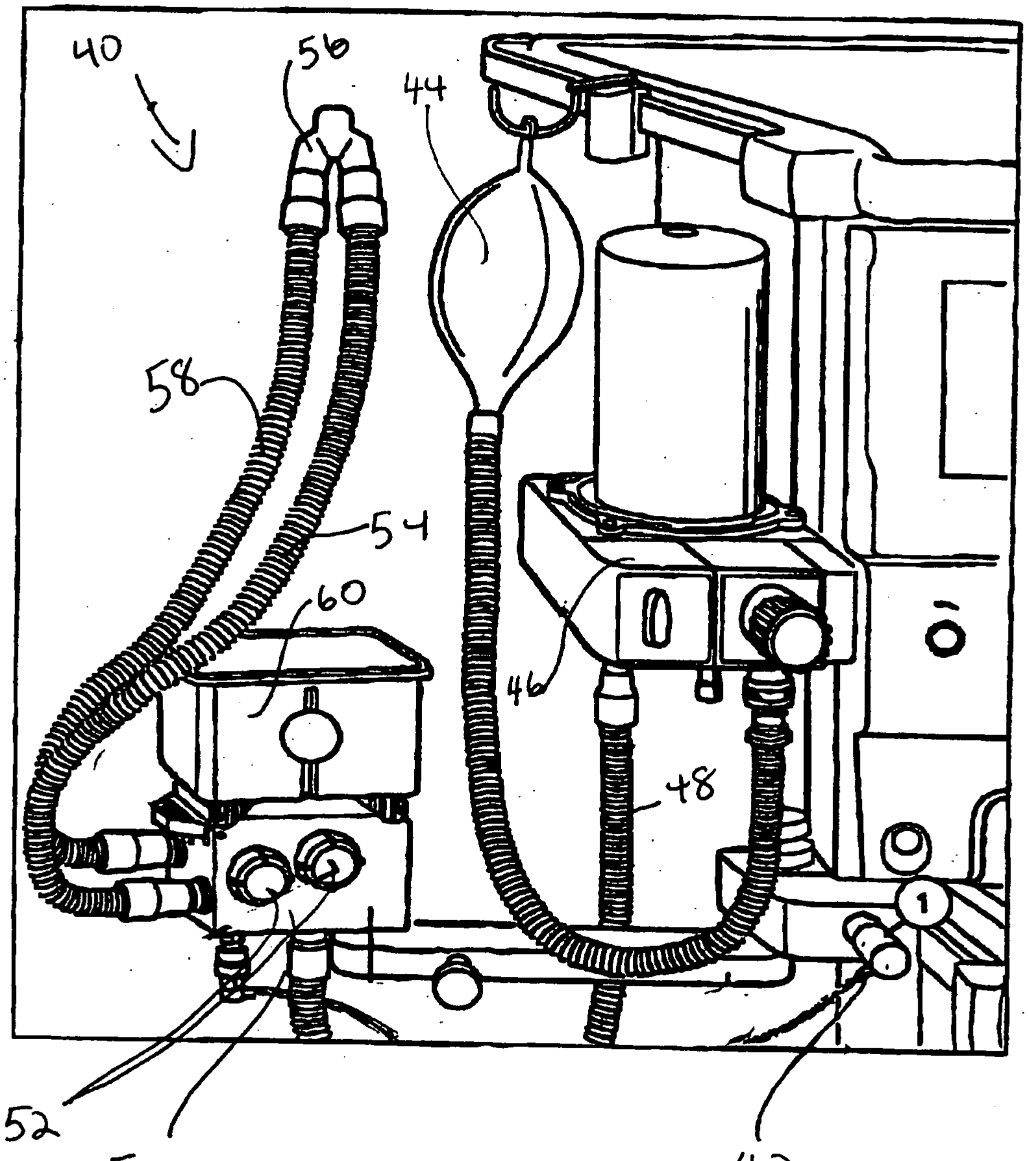
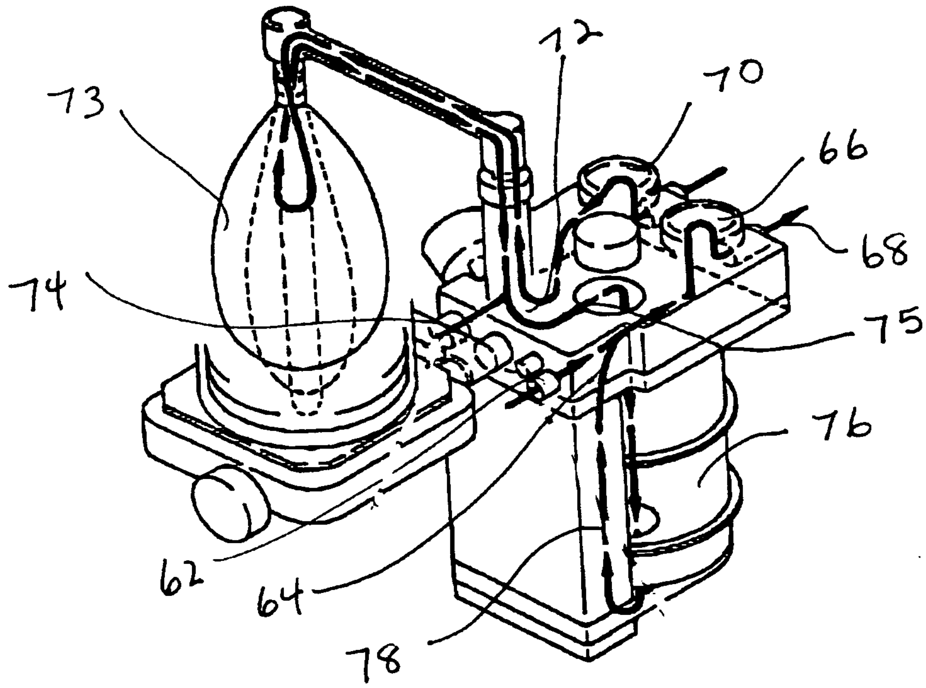


Figure 2



PRIOR ART

Figure 3

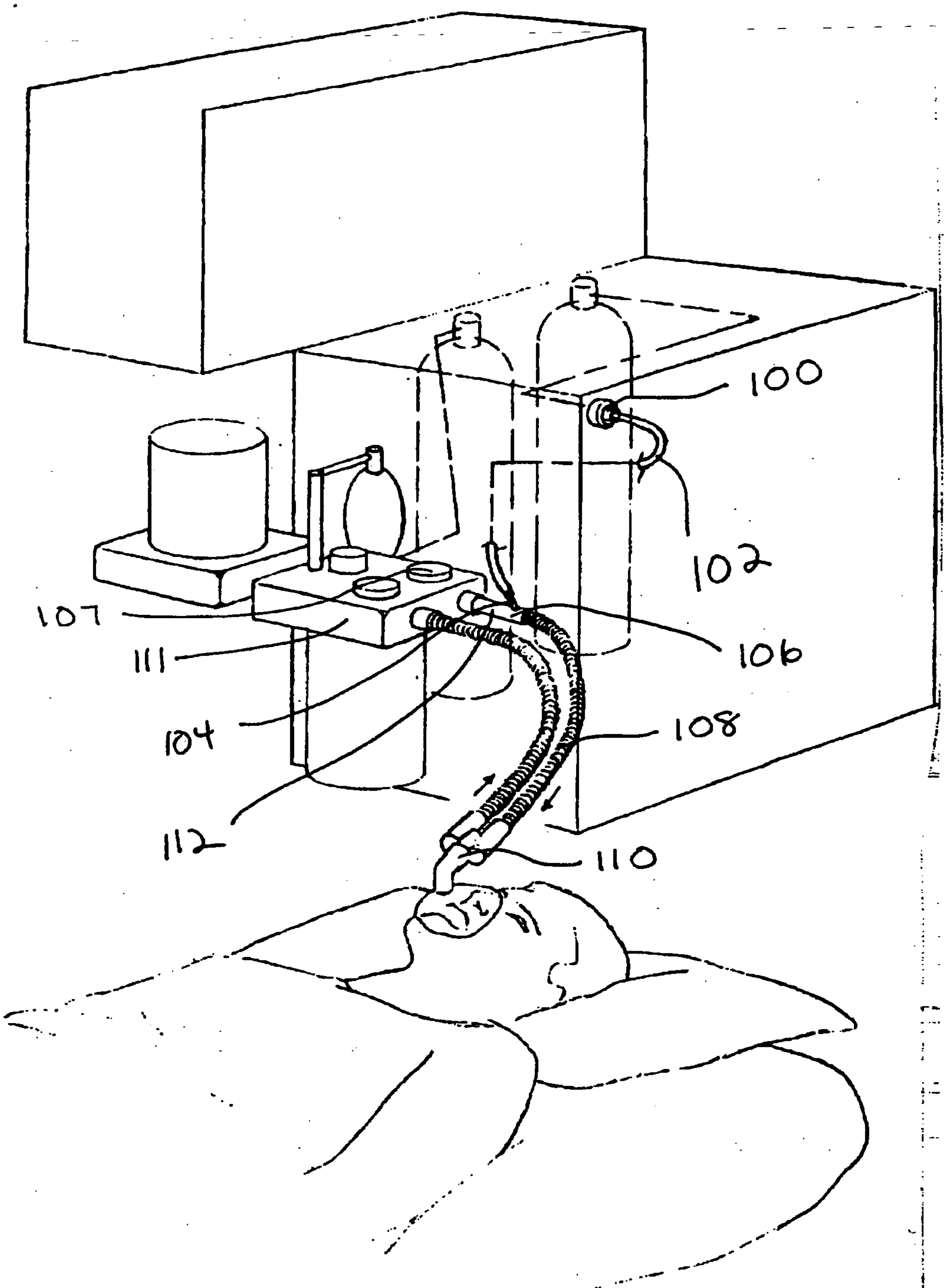


Figure 4

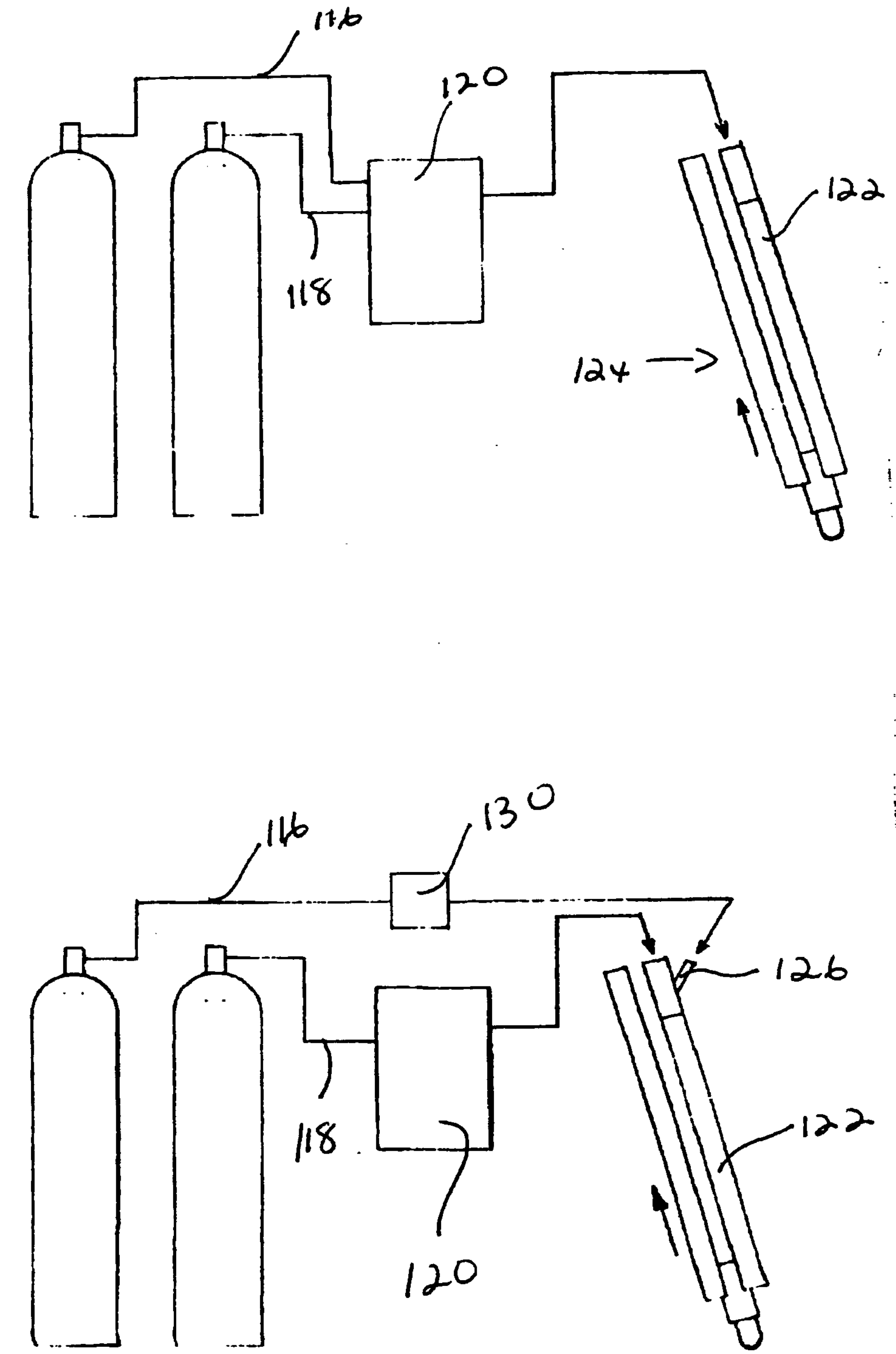


Figure 5

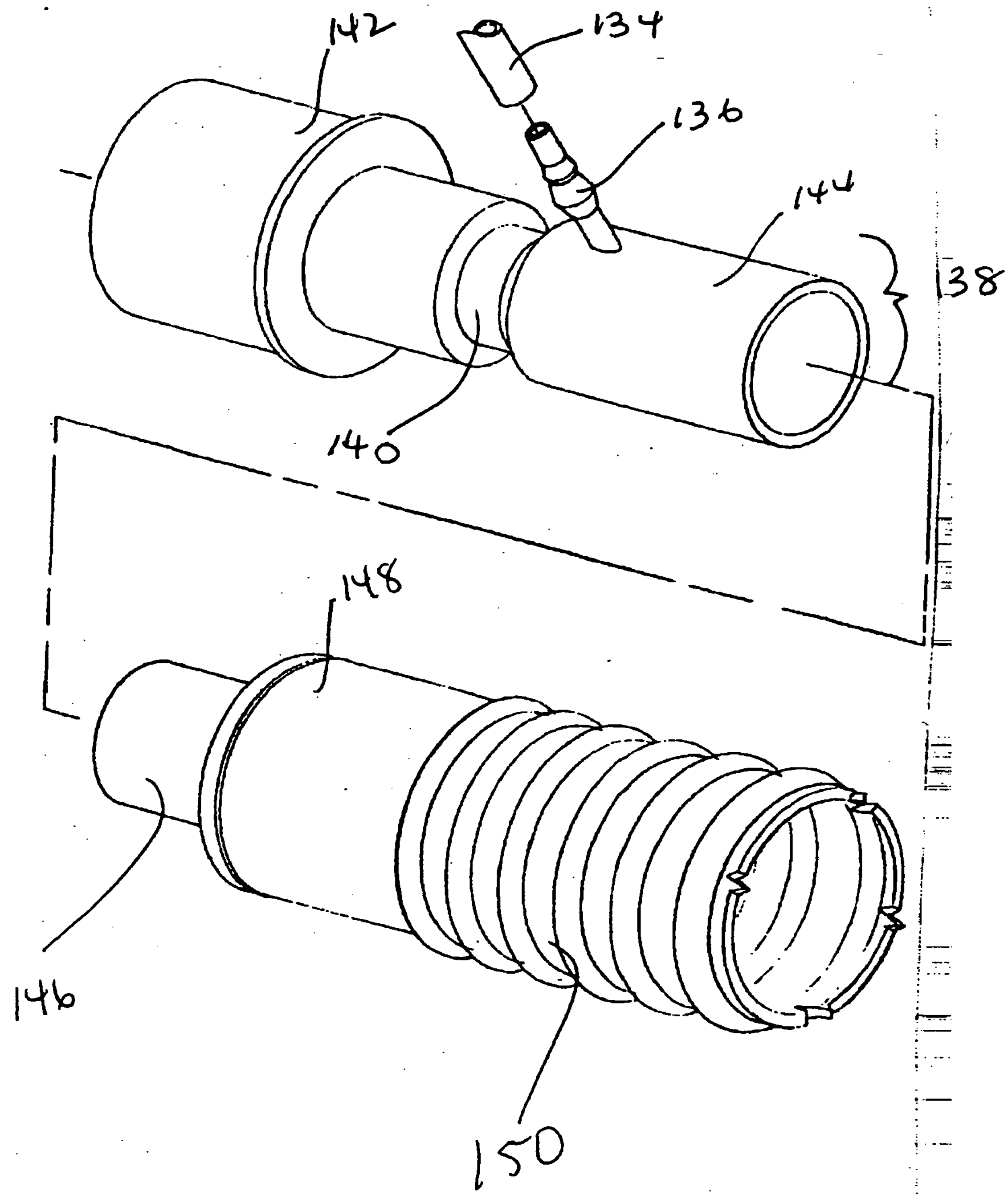


Figure 6